Plenary Session

Impact of Renewable Energy Sources on the Power Scenario of Developing Countries

Namaste
&
Good Morning

15th Sept 2014
Pittsburgh – USA

S. S. Mani,
General Manager(Renewable Energy Projects)
NTPC Ltd, India
ssmani@ntpc.co.in
ssmanintpc@yahoo.com

एनटीपीसी
NTPC

A Maharatna Company

Power of India

Agenda

1	*Triggers Of Change Igniting Renewable Sources*
2	*Renewable Energy Sources* ➢Impact on Global & Indian Power Scenario – Vital Solar & Wind ➢Grid Interconnection Challenges ➢Indian Renewables – The Road Ahead ➢Renewables - Challenges
3	*Renewable Energy –The Future Scenario*
4	References & Acknowledgements

Need For Change

"It is not the Strongest of the Species that Survives, nor the Most Intelligent, but the One Most Responsive to Change".

– Charles Darwin

Only CHANGE is Permanent & CHANGE is Inevitable

The Only Thing that Doesn't Change is – CHANGE

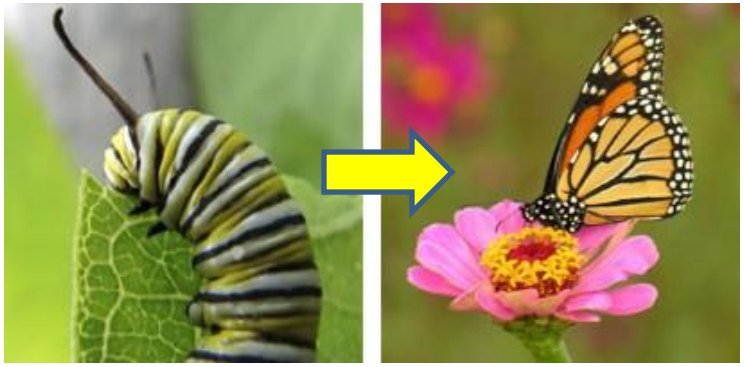
What has Not Changed Significantly over the last Two Decades?

Technology Has Become One of The Main Drivers of Economic & Social Development.

Convergence of Computers & Communication (IT Synergy, Digital Technology, Internet etc) has Transformed Not Only the Way We Think, But Also The Way We Act.

Transformation

All Change MUST Be for Better.
Change MUST Bring TRANSFORMATION &
Not just Transition, in fact it should be
TRANSITIONAL METAMORPHOSIS

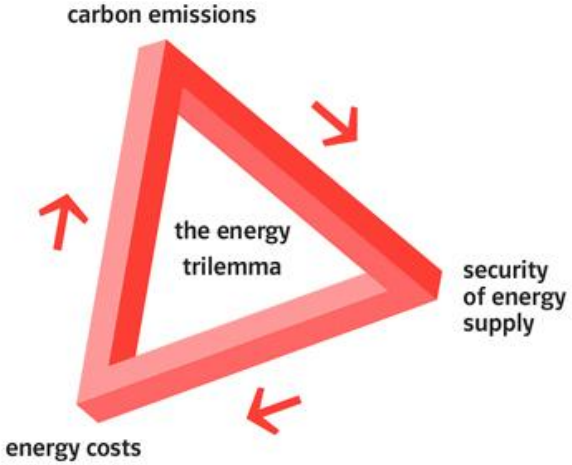


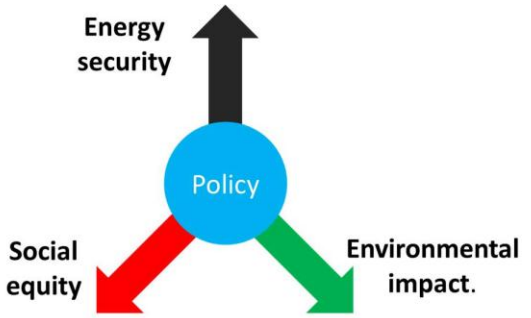
When the World Developed, Changed for Good/Better, the Climate Also Did Undergo Change Which is Not A Good Change.

Human Induced Climate CHANGE – Green House Gas (GHG) Emissions Mainly from Fossil Fuels / Energy Sector – It's Time for Us to CHANGE so that Future Generation is Not Deprived of their Right to Live in A Clean & Green Environment

"Sustainable Development is Development that Meets the Needs of the Present Without Compromising the Ability of Future Generations to Meet Their Own Demands"

ENERGY TRILEMMA (WEC) & UN's INITIATIVE OF SE4ALL(SUSTAINABLE ENERGY FOR ALL)





"Struggle to Reconcile 3 Conflicting, But Vital Imperatives – Sourcing the Energy Essential to Meet the Needs @ Prices that Everyone can Afford, Ensuring that Supplies are Sustainable wrt Impact On Climate & Air Quality" – Energy Trilemma as per WEC

"SE4ALL United Nations Initiative Proposed by Secretary General Ban Ki – moon in 2011 – Objectives by 2030 – Enable Universal Access to Modern Energy Services, To Double the Rate of Improvement in Energy Efficiency & To Double the Share of Renewables in The Energy Mix."

"Sustainability is a Luxury, We can't Afford". "Industrialize Fast, Produce Now, Clean up Later" – Both Old Paradigms, as Cost of Cleaning Up is Very High"

"Not Whether or not We can Afford it. We very clearly can't Afford NOT to"

World Today: One in Five people Has No Access to Electricity & Two in Five are Without Clean Cooking Facilities

Source: World Energy Focus – WEC Publication July 2014 / Internet/GWEC 2013

Renewable Energy – 5W1H – Perspective

Why?

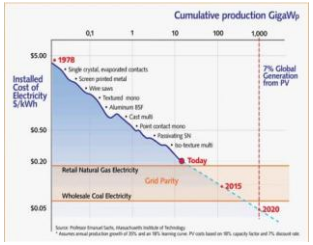
Depleting Fossil Fuel

Inflationary Fossils

Green House Gas (GHG) Emission

Global Warming

Energy Security



Deflationary RE

WHAT ?

Forms of Energy Which are Not Exhausted by Use Over Time, Perennial in Nature.
Resources Naturally Replenished on a Time Scale (viz Sun Light – Solar Irradiance / Wind – Moving Air – Kinetic Energy / Rain (Water – Potential Energy – Large –Small Hydro – Mini – Micro) / Geo Thermal / Marine– Tidal/Ocean & Renewable Sources from Human Activity (Biomass, Industrial Heat Recovery, Land Fill Gas – New Renewables)

Hydro Power

Wind

Solar

Bioenergy & Waste

Geothermal

Marine Energies

How ?

Enabling Policy Framework & Legislation

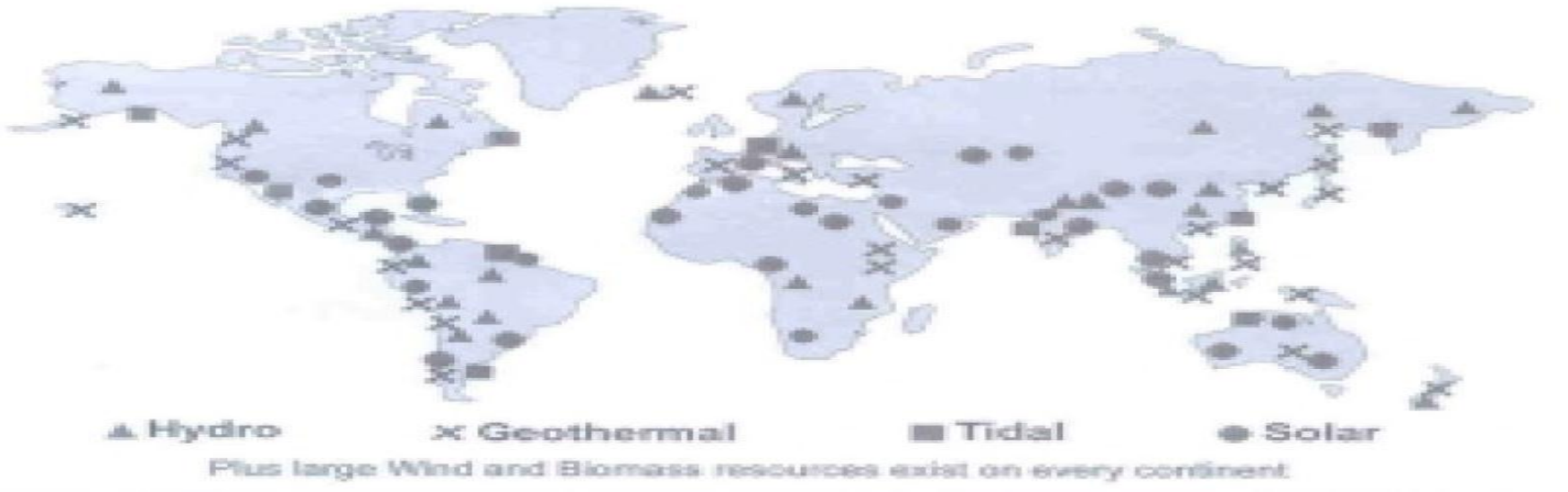
Investments / Affordable Technology

When? & Where?

Who?

By All 'Prosumers'

Global Renewable Energy Resources



Source: WEC RE Projects Hand Book 2004 / Global Energy Network Institute (GENI) www.geni.org

Solar: Even 0.1% of Total Solar Energy Reaching Earth is Harnessed @ 10% Efficiency, it would be 4 times Larger than the Global Electricity Generating Capacity – WEC Survey Summary 2013. About 50 Times to Power the World as per Global Wind Report Annual Market Update 2013 of GWEC

Wind: About 7 Times to Power the World as per Global Wind Report Annual Market Update 2013 of GWEC. As per WEC 2013 Summary, Estimated Wind Capacity – A Million GW 'For Total Land Coverage'. Even 1% of this @ CUF of 15-40% will be Equal to Global Electricity Capacity Today.

71 Countries have more than 10 MW, 24 Countries have more than 1GW Installed.

Denmark's Electricity 33.2% from Wind during 2013 – REN 21 – 2014 Status Report

Impact of Renewable Sources on Global Power Capacity (GW) During 2004-2013

Renewable Energy Sources	Start of 2004	End 2012	Addition in 2013	End 2013	Leading Countries
Renewable Excluding Hydro	85	480	80	560	China, USA, Brazil, Canada, Germany
Renewable Including Hydro	800	1440	120	1560	China, USA, Germany, Spain / Italy, India
Hydro	715	960	40	1000	China, Brazil, USA, Canada, Russia
Solar PV	2.6	100	39	139	Germany, China, Italy, Japan, USA
Concentrated Solar Thermal (CSP)	0.4	2.5	0.9	3.4	Spain, USA, UAE, India, Algeria
Wind(On Shore &Off Shore)	48	283	35	318	China, USA, Germany, Spain, India
Wind(Off Shore) (Global Wind Report – Annual Market Update – 2013 – GWEC)	–	5.42	1.63	7.05	UK, Denmark, Belgium, Germany, China, Netherland, Sweden
Geo Thermal	8.9	11.5	0.5	12	USA, Philippines, Indonesia, Mexico, Italy
Bio Mass	<36 (227 TWh)	83 (350 TWh)	5 (55 TWh)	88 (405 TWh)	USA, Germany, China, Brazil, India
Tidal	0.3	0.53	–	0.53	South Korea, France, Canada, UK, China

Significant Growth in 2013 – 8% More than 2012, Hydro 4%, Other Renewables 17%

First Time World Added More Solar PV than Wind ***Source: REN21 – Renewables 2014 Global Status Report***

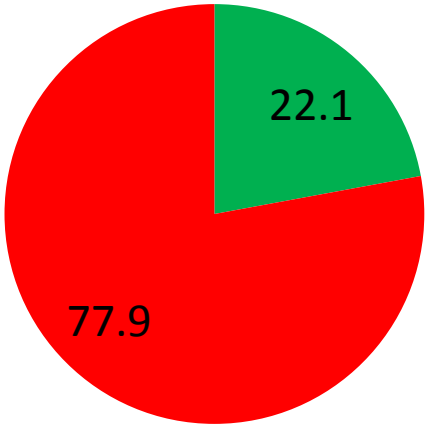
Impact of Renewable Sources on Global Power Scenario – Who is Where? (As on End 2013)

Criteria	Pioneers
Renewable Power Capacity per Capita Excluding Hydro	Denmark, Germany, Portugal, Spain / Sweden, Austria
Hydro Power	China, Brazil, USA, Canada, Russia
Solar PV Capacity per Capita	Germany, Italy, Belgium, Greece, Czech Republic
Wind Power Capacity per Capita	Denmark, Sweden, Spain, Portugal, Ireland
Renewable Manufacturing Capacity – Market Share of MNCs – Country Wise	WTGs – Germany, China, Denmark, USA, Spain, India Solar PV Cells – China, Germany, USA, Canada, Japan, South Korea Solar Inverters – Germany, USA, India, Japan, Italy, China
Largest Employers in Renewable Energy (6.5 Million Jobs in 2013 – 14: Directly & Indirectly)*	China, Brazil, US, India, Germany, Spain, Bangladesh (As per Report by Bridge to India & Tata Power Solar: About 0.7 million Jobs Expected in India in next 10 Years in Solar Sector – Estimated 145 GW – Financial Chronicle 2nd Sept2014)
Largest Employing Sectors in Renewable Energy*	Solar PV, Bio Fuels, Wind, Modern Bio Mass & Bio Gas.
Investment in Renewables During 2013 (Highest So Far 279 (**187 + 92) Billion USD in 2011)	214 Billion USD (**122 by Developed Countries, 93 by Developing Countries)
Investment in New Renewables Relative to Annual GDP	Uruguay, Mauritius, Costa Rica

Source: REN21 – Renewables 2014 Global Status Report

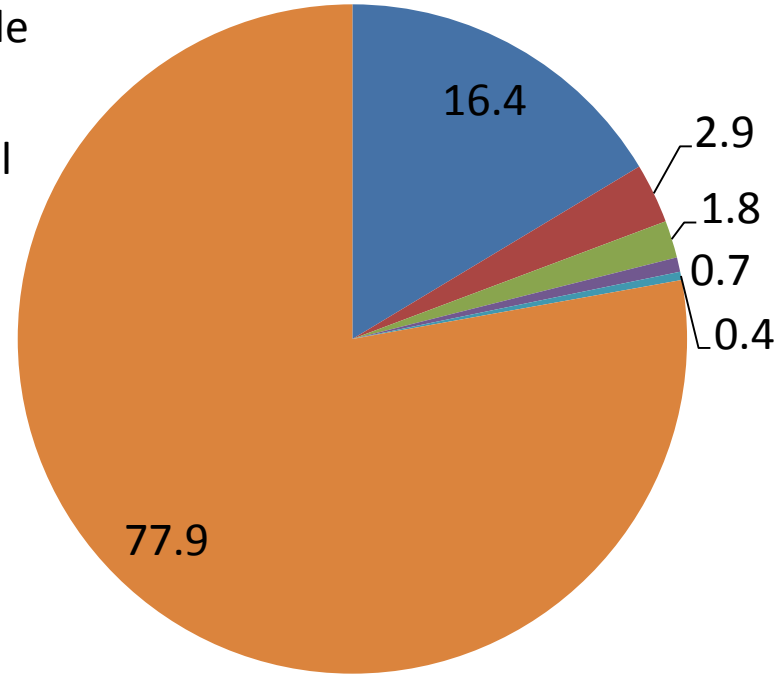
**The International Renewable Energy Agency (IRENA) – 'Renewable Energy & Jobs' – Annual Review 2014 – Media Report*

Impact of Estimated Renewable Energy – % Share of Global Electricity Production (End 2013)



Renewable Energy

Fossil Fuel



Hydro

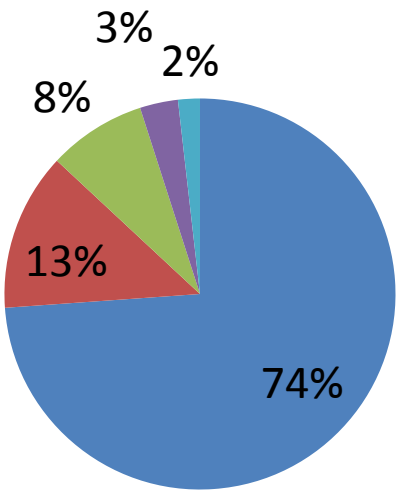
Wind

Bio Power

Solar PV

Concentrated Solar PV

Fossil Fuel



Hydro

Wind

Bio Power

Solar PV

Concentrated SPV

Global Electricity Capacity – 5500 GW

***Estimated Capacity By 2030 – 10,500 GW**

***Estimated Renewable Generation by 2035 >25%**

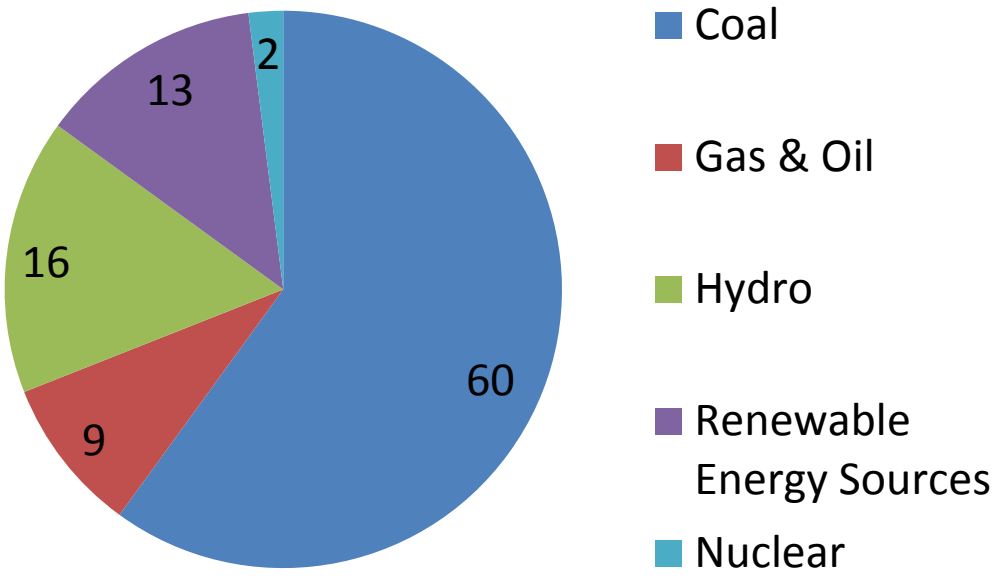
Estimated Share of Wind Generation by 2035 – 25% of Renewables(2nd after Hydro) as per IEA

Source: REN21 – Renewables 2014 Global Status Report/WEC Data/*GWEC Update 2013

Indian Power Scenario

Fuel	GW	%
Coal	149.178	60
Oil & Gas	23.808	9
Hydro(Large)	40.799	16
Renewable Energy Sources	32.424	13
Nuclear	4.780	2
Total	250.989	100

Installed Capacity as on July 2014



NTPC's Installed Capacity: 43 GW (Includes 95 MW Solar PV Portfolio)
ie About 18% of India's Installed Capacity providing 1/4 th of Country's Generation

3rd Largest Economy of the World (GDP – 6.4 trillion USD) After USA & China, but per Capita Electricity Consumption is only 917 kWh (Provisional – 31% of World Average), lagging China by over 3.6:1

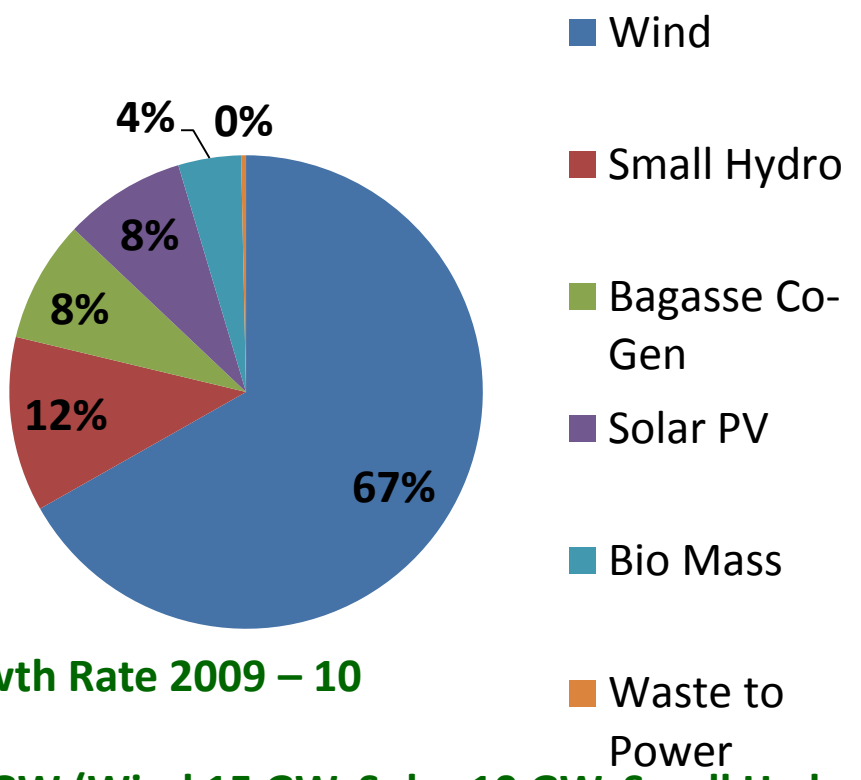
XII Plan (2012-17) Target – 88 GW from Conventional Sources & 30 GW from Renewables.

Source: Website of Central Electricity Authority & MNRE, Ministry of Power / Government of India, World Bank / IEA

Indian Power Scenario – Impact of Renewables

	GW	%
Wind	21.693	67%
Small Hydro	3.826	12%
Bagasse Co – Gen	2.680	8%
Solar PV	2.753	8%
Biomass	1.365	4%
Waste to Power	0.107	
Total	32.424	

Installed Capacity as on July 2014



Wind Energy Debut in India 1990s,Highest Growth Rate 2009 – 10

Solar Energy Debut in India 2009.

XII th Plan (2012 – 17) Renewables Target – 30 GW (Wind 15 GW, Solar 10 GW, Small Hydro 2GW,Bio Power 3 GW). By 2022 Renewable Capacity Cumulative Target 72GW.

NTPC's Solar Portfolio Today: 95 MW ie 3.4% of India's Solar PV Installed Capacity

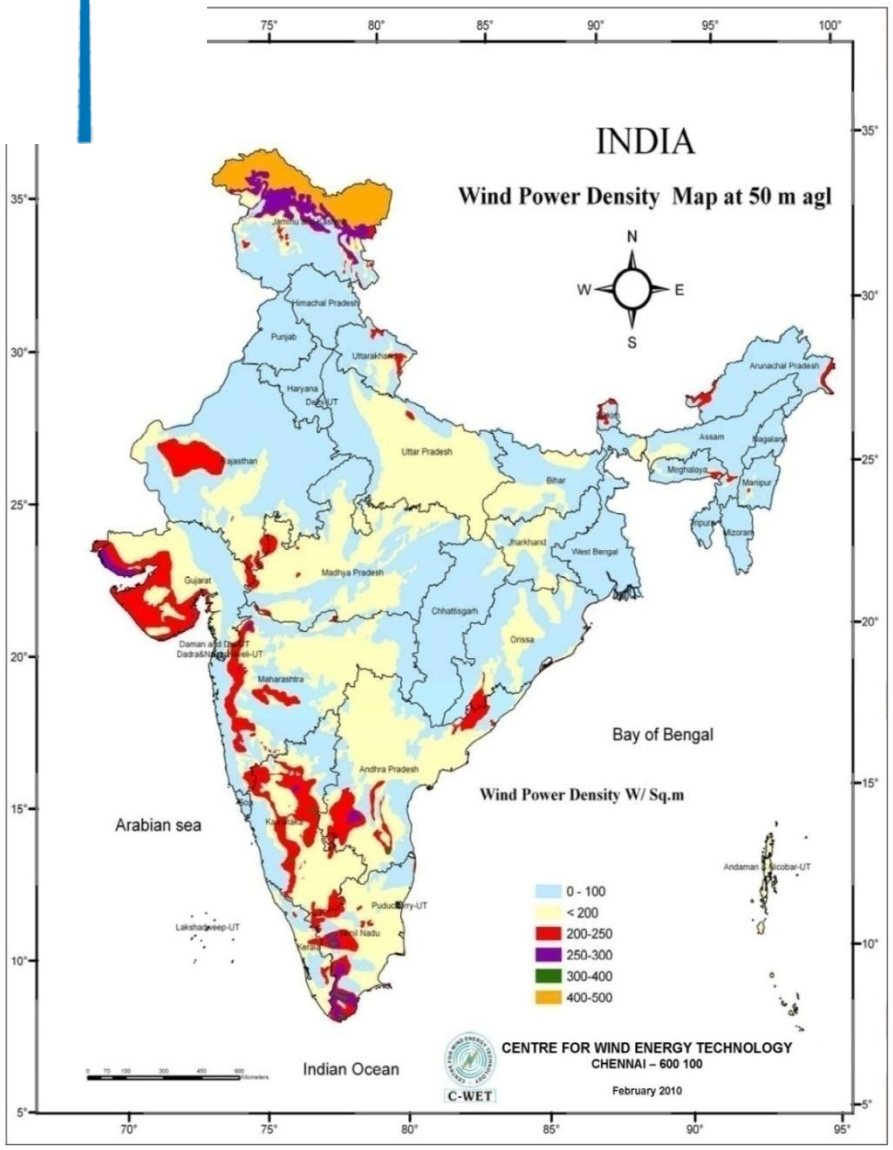
Planning for 1000 MW RE Portfolio by 2017 & By 2032 – 9% of NTPC's Total Installed Capacity of 128 GW will be from RE Sources ie 11.5 GW

15MW Solar PV, 8 MW Small Hydro & 1491MW Large Hydro Already Under Construction

Source: Website of Ministry of New & Renewable Energy Sources / Government of India & NTPC Ltd

WIND RESOURCE MAP OF INDIA

(On Shore – Widely Distributed – Coastal or Mountainous Locations)



Estimated Capacity	102 GW @ 80 m AGL
Installable Capacity WPD>200 W/m^2 Land 2 Ha/MW	49 GW @ 50 m AGL
Installed Capacity (May 2014)	21 GW
12th Plan (2012 – 17) Target	15 GW Out of Total 30 GW Renewables
CUF	20 to 32 % (80% of this during 3 – 4 Months Wind Season & Balance 20% During 9 – 8 Months Non Windy Season)
Grid Penetration	Presently 9%

National Wind Energy Mission (NWEM)
Launching Anticipated in 2014 – 15
Target: 100 GW by 2022 (10 GW / Year)

Off Shore Wind (Global & Indian)

>90% of Global Off Shore Installations in European Waters(North Sea, Baltic Sea, Atlantic Ocean) Cost Down by 30% per Decade, WTG Size Increased from 450 kW to 7 – 8 MW, Moved to 40 m Depth & 100 km from Shore. Pioneers: UK, Denmark, Belgium, Germany, China, Netherland, Sweden

China's Off Shore Starting to Take off followed by Japan, South Korea, Taiwan & US.

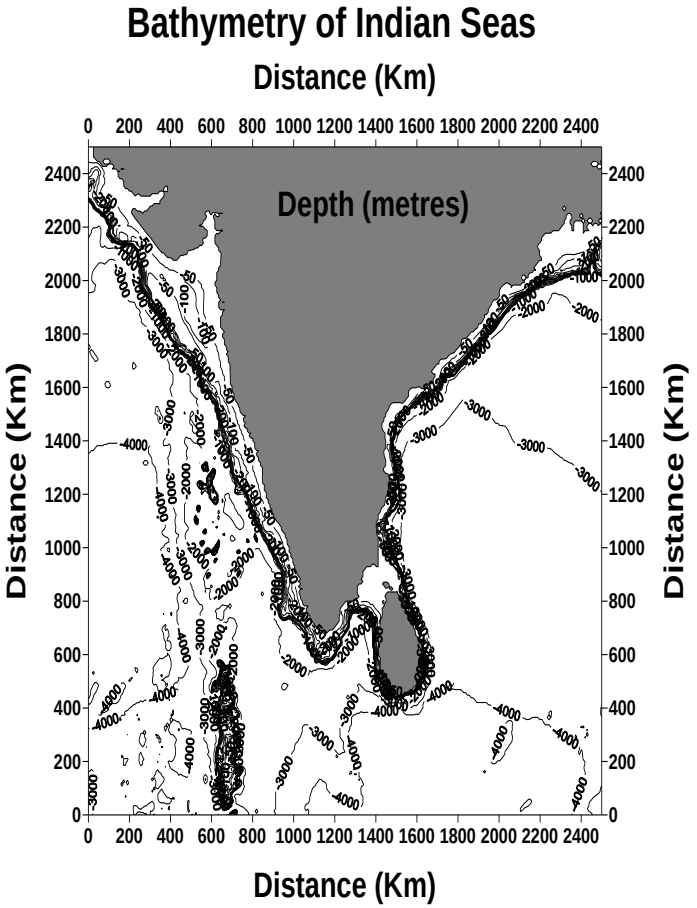
INDIAN OFF SHORE

Wind Resource Assessment @ 100m Height in the Off Shore Areas Near Rameswaram (North of Danushkodi) & Kanyakumari in the Southern Tip of India & Gujarat in Western Coast, being Studied by Centre for Wind Energy Technology (C – WET).

Estimated Potential 1000 MW each.

Estimated Cost INR 180 – 200 million per MW for Minimum 100 MW Capacity.

15 m Deep in < 10 km Anticipated CUF 30% to 40%

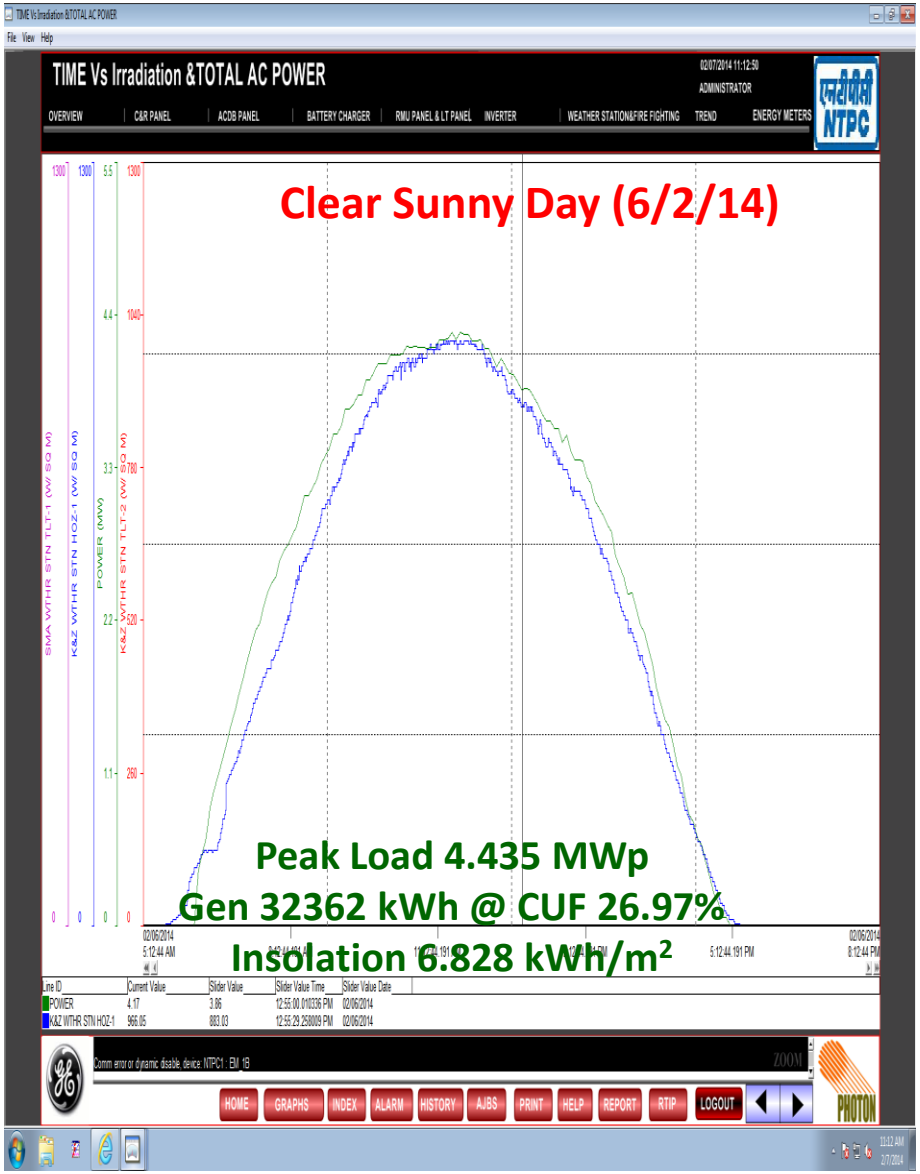


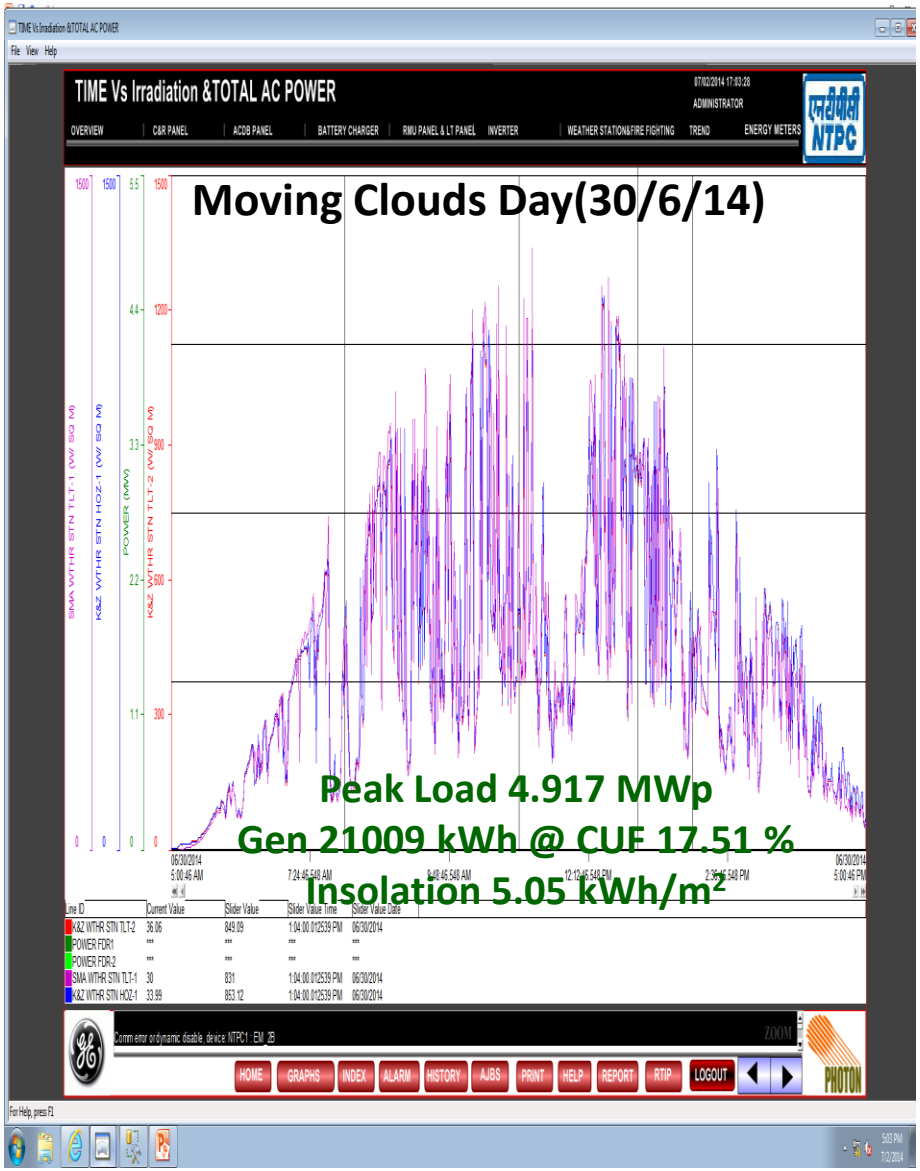
"Concept Good, Clean & Stable, but Can't afford Off Shore Wind"

Cost Reduction of 15 to 27 % Anticipated by 2025 Through WTG MW Capacity Increase, Advanced Blade & Foundation Designs etc.

Renewable Energy Sources – Grid Interconnection Challenges (Wind & Solar PV)

Plant Loading Fluctuations:
Typical Power/Loading Curves of 5 MWp Solar PV Plant





Renewable Energy Sources – Grid Interconnection Challenges (Wind & Solar PV)

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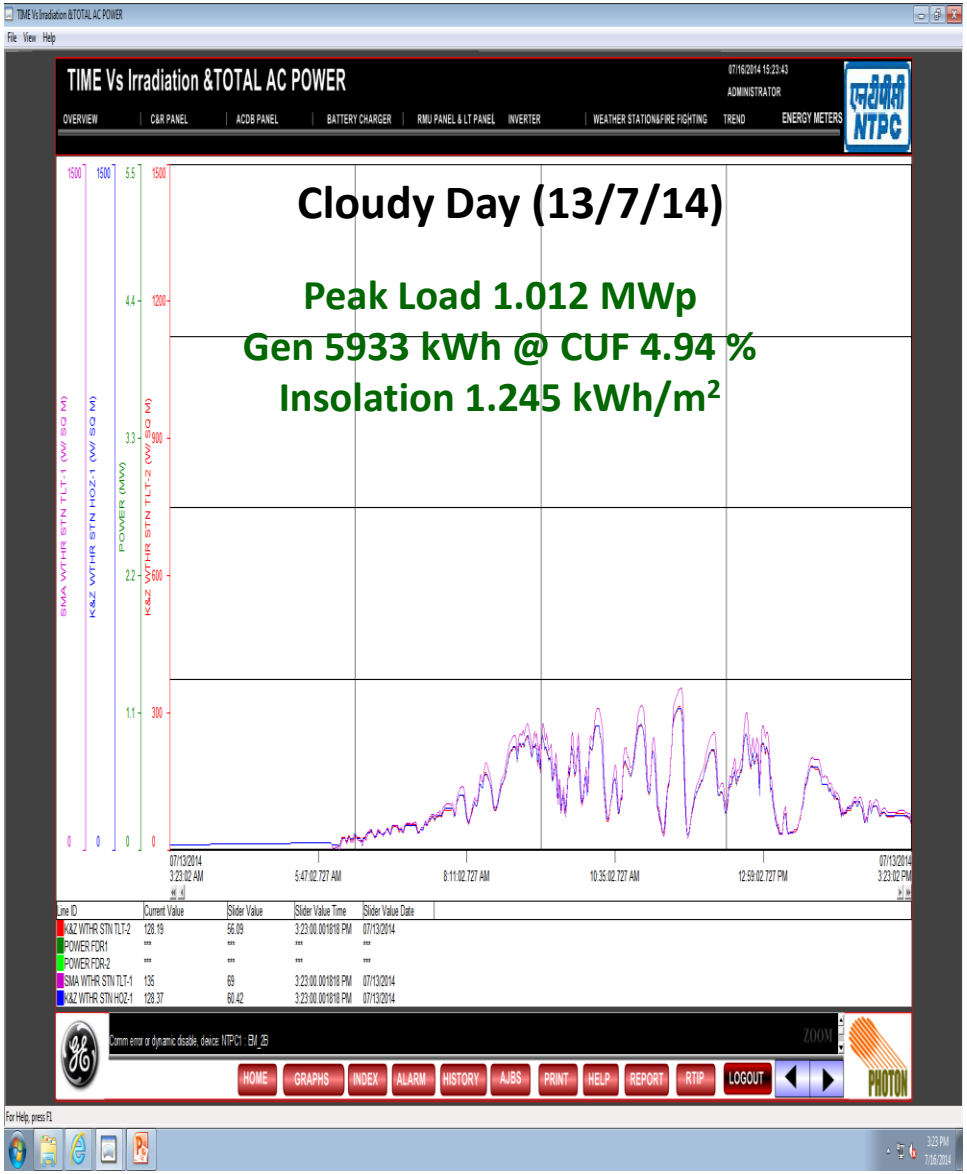
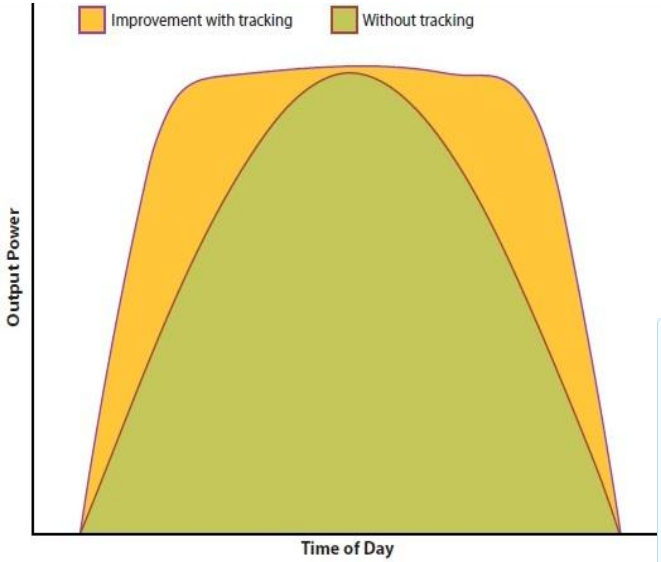


- **Challenges – Seasonality, Variability, Intermittency & Ramping . Sudden On Set Or Off Set of Generation**
- **Remedies – Generation Balancing by the Conventional Energy Sources – Spinning Reserve**
- **Greater the Penetration Greater the Balancing Requirement**
- **Forecasting of Renewable Generation Including Ramp (Solar & Wind)**
- **Ramp Management – A Challenge to the System Operators Especially in the Context of Higher Penetration of Renewables**
- **Renewable Sources Located Far Away Necessitating Grid Extension & Augmentation**
- **Separate Renewable Grid (Smart?) &/Or Decentralized / Distributed RE Generation**
- **Dynamic VAR Control & Metering**

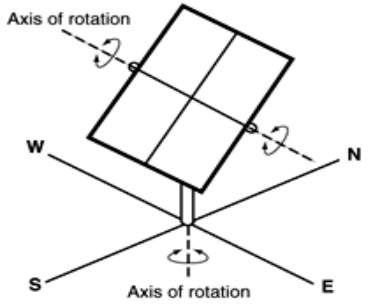
Renewable Energy Sources – Solar PV & Wind

CUF Improvement & Load Servicing – Solar PV Tracking & WTG Pitching / Yawing

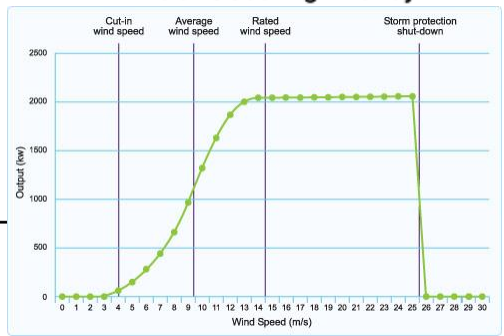
Estimated CUF Improvement for Solar PV	
Position	**CUF %**
Fixed Tilt Angle	16-19
Seasonal Tilt	1.04 times
Single Axis Tracking	1.15 times
Double Axis Tracking	1.3-1.4 times



CUF Improvement of Solar PV With & Without Tracking



Two-axis tracking PV array



WTG Power Curve

Tracking in Solar PV Increases Cost & Aux Power Consumption, Affects Plant Reliability, But Improved CUF, Better Grid Integration & Load Servicing In Wind Turbine Generators – Pitching & Yawing Improves CUF & Load Servicing

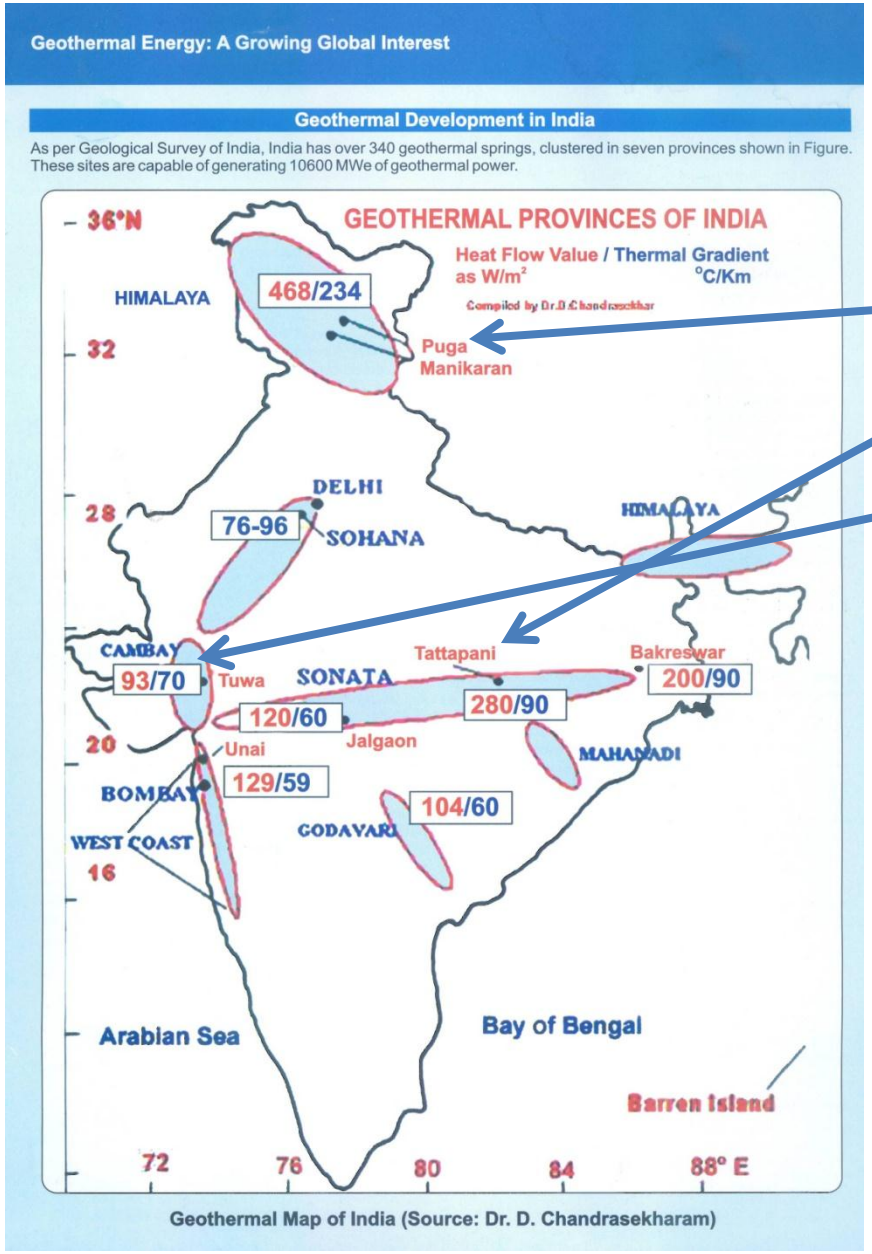
Renewable Energy Sources – Geo Thermal

The Emerging Potential Renewable Energy Source

"Geothermal Energy could be a Triple Win for Developing Countries: Clean, Reliable & Locally Generated. Once it is Up, it is Clean, Reliable & Virtually Endless" – Sri Mulyani Indrawati, MD&COO/World Bank(Indonesian Economist & Former Fin Minister/Indonesia)

Resource Availability	**Heat Stored Beneath the Surface of the Earth. Originates from the Earth's Molten Interior & Decay of Radio Active Materials. Constant Availability @ Few Places.**
Energy Conversion Technology	**Dry Steam, Flash Steam, Binary Cycle, Combined Cycle, Hot Dry Rock(HDR)**
World Scenario / Leading Countries	**12 GW Globally, USA – 3.4 GW, Philippines – 1.9 GW, Indonesia – 1.3 GW, Mexico – 1 GW, Italy – 0.9 GW, New Zealand – 0.9 GW, Iceland – 0.7 GW & Japan – 0.5 GW. About 12 GW under Construction in 70 Countries & 27 GW are under Active Consideration (Turkey, Kenya etc)** ***At Sarulla in North Sumatra, a 330 MW ($ 1.6 Billion)Project, could be the World's Biggest, Planned by Indonesia, who is targeting 12% (currently 2%)of Geo Thermal in the Energy Mix by 2025.** **(* Media Report – Business Standard – 10th July 2014)**
Capacity Utilisation Factor(CUF)	**Above 90% (Anticipated Depending upon Source Reliability) Resource Assessment Critical Success Factor / Risk Analysis**
Challenges	**Unless used in Binary Closed Cycles with Fluid Reinjection – includes small Quantities of Dissolved Gases including H_2S, CO_2, CH_4, NH_3 etc, Toxic Chemicals in Hot Water, Problems with Disposal of used Brines and Land Stability / Earthquake etc.**

Geo Thermal & Tidal Resources – India



Geothermal Map of India (Source: Dr. D. Chandrasekharam)

Geo Thermal

Estimated Potential	10.6 GWe
Promising Sites	6 Locations as per 2001 – 02 Study by M/s Geotherm Ex, USA
Demonstration Project	5 MWe Under Development
NTPC is Studying the Feasibility of Setting Up A Geo Thermal Plant @ Tattapani	
Gujarat Govt is Exploring in Collaboration with Norway	
Govt of India MOU's with Australia, Iceland & Philippines for Scientific Co – Operation & Research.	

Tidal

Estimated Potential	Total 8 GW (@ 3 Locations)
Location Wise Potential	7 GW @ Gulf of Cambay,1.2 GW @ Gulf of Kutch & 0.1 GW in Sunderbans Region/Gangetic Delta
First Project	First 50 MW Project to come up in Kutch @ An Estimated Cost of USD 162 Million

Indian Renewables – The Road Ahead

Jawaharlal Nehru National Solar Mission, Ministry of New & Renewable Energy.	20 GW Grid Connected/Grid Parity Solar by 2022 Phase I – 2012 – 13 – Batch I – 140 MW PV, 50 MW CSP, Batch II – 340 MW PV – Completed. Phase II – 2013 – 17 – Batch I – 750 MW PV with Viability Gap Funding from National Clean Energy Fund (NCEF) – Planned. Phase III – 2017 – 22
Large Solar PV Projects	Ultra Mega Solar PV Projects @ 4 Locations - 4 GW By 2020 NTPC Planning 1000 MW Solar PV Solar Wind Hybrid for Greening of Deserts & Solar Powered Agricultural Pumps DG Capacity Displacement through Solar PV
National Wind Energy Mission – XII / XIII Plan (2012 – 17 & 2017 – 22) Anticipated to be Announced During 2014 – 15	100 GW by 2022 (10 GW / Year)
Investment by World Bank in Clean Energy Projects	775 Million USD Anticipated as per Media Report (Economic Times 7th July 2014).
Grid Augmentation	Renewable Grid Upgrade for Handling more than Double of Existing Renewable Power Capacity by 2022 – German / KfW Funding – 8 Billion USD
Roof Top Solar & 'Prosumers'	This is being Encouraged through Enabling State / Federal Policies of Feed In Tariff and Energy Banking / Net Energy Metering. Big Corporates / IT Companies Developing their Own Solar Parks. Banks, Railways, Defence & Large Energy Intensive Industries like Oil & Gas Companies, Aluminum, Steel, Power Utilities etc also have RE Generation Plans.

Renewable Energy – Strategy Formulation & Implementation – START in a SMART Way Using 5W1H Approach

START: Synergetic Technology Appropriate for Rapid Transformation (Results – What/Where ?) – Industry Aids / Head	SMART: Synergetic Measures Aiding Radical Transformation (Enablers – How ?) Policy Aids / Heart
Resource Assessment(WRA/SRA etc)Energy Estimation(of Locally Available Renewable Energy Sources) & Optimization, Bankable Projects	Paradigm Shift wrt Perceptions on Barriers and Success Factors (viz Costly, NIMBY Syndrome etc.)
Technology for Exploiting the Potential Renewable Energy Sources. Advantage of Deflationary Cost Trends in Solar PV (60 - 65 % Reduction) Innovative Technological R&D / Maturity, Economics of Scale, Learning Curve Benefits.	Policy Advocacy as Catalyst. Industry & Policy Makers Continuous Engagement for Synergy.
Solar – PV(Mono Crystalline Silicon(c – Si)Most Efficient – CUF 16 – 21 % – Tilting/Tracking, High Capacity 2 MW+ IGBT Inverters, Energy Storage: High Capacity / Efficiency Battery Storage? / Solar Energy Storage – Nano Technology?. Concentrated Solar Power – Solar Thermal – CUF 23% – Parabolic Trough, Fresnel Mirror, Sterling Dish, Tower	Enabling Policy Framework (Incentives like Accelerated Depreciation, Generation Based Incentive, Concessional Taxes / Duties, Renewable Purchase Obligation(RPO), Renewable Energy Certificate (REC), Renewable Generation Obligation(RGO), Certified Emission Reduction (CER) – Carbon Market, Clean Development Fund, RE Targets (144 Countries Already have RE Targets)
Wind – On Shore(2 – 5 MW) / Off Shore (4 – 8 MW) Horizontal Axis(Widely Used)/ Vertical Axis WTGs – Geared/Gearless – Induction Generator / Synchronous Alternator – 50 mt+ Long Blade Logistics Constraints in High Terrains, Joinable Blades?	Financing – Viability Gap Funding, Social Cost Benefit Analysis / Society's Cost of Electricity (SCOE) Vs Levellised Cost of Electricity (LCOE).
	Tariff – ROE to Developers, Affordability to Consumers (Bundled / Pooled Tariff), Grid Parity of Solar PV/On Shore Wind. Feed in Tariff for 'Prosumers' on Net Energy Banking.
	Overall Institutional Frame Work for Robust Growth.

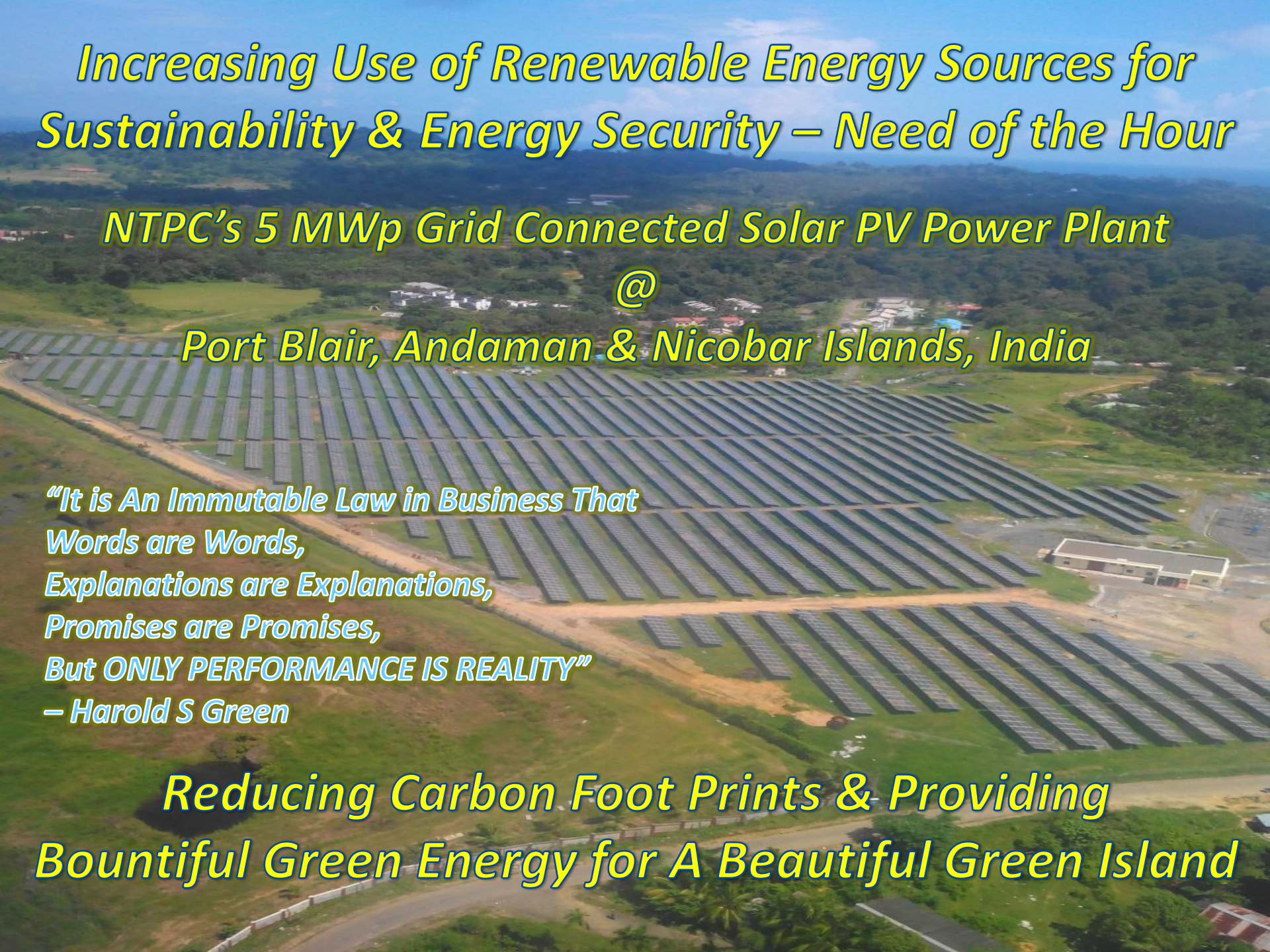
Renewables' Challenge Matrix – Environment, Cost & Availability

Renewable Source	Environmental Factors	Cost Economics	Resource Availability/CUF
Large Hydro (Reservoir Storage)	Submergence, Rehabilitation & Resettlement, Safety	High Capital Cost – Fixed Cost, No Variable/Fuel Cost	CUF – 20-90% – Peaking &/or Base Load
Small Hydro (Run – of – River)	Low Impact on Streams	High Capital Cost – Fixed Cost, No Variable/Fuel Cost	Hydrology Dependent, CUF – 40-90%
Wind – On Shore	Visual Intrusion, Noise, Bird Migration/Mortality, Tele Communication Interference, Large Area – Off Shore an Option?	FC/kWhr High considering Low CUF, No VC	Highly Variable/ Intermittent, CUF – 20-30%
Wind – Off Shore	Marine Ecology, Marine Navigation, Corrosion Issues etc	High Capital Cost – FC/MW, No VC	Higher CUF 30-40%
Solar PV	Large Area(Land Scarcity), Disposal of PV Modules/Battery Exploiting Roof Top Options.	FC/kWhr High considering Low CUF, No VC	Inter/Intra Season Variation, Weather Dependent.
Solar Thermal	Large Area/Land Scarcity – Water Requirements like Thermal	High FC/Capital Cost	CUF 23%,Flat Land, Solar Resource Assessment Must.
Geo Thermal	CO_2, H_2S, CH_4, NH_3, Toxic Chemicals in Hot Water, Land Stability – Earthquake	High Capital Cost/FC	CUF 90%(depends on source), Available in Selected Places only, Depletion over Time?
Bio Mass (Carbon Neutral)	Local Bio Diversity & Environment	High Cost due to Low Load Factor	Seasonal, Climate & Technology Dependent
Tidal	Marine Ecology, Navigation, Corrosion	High Capital Cost	Location / Source Dependent

Future Energy Scenario & Renewables

Demand For Energy will Continue to Grow with Increasing Population & Growing Rate of Electrification.
Global Primary Energy Demand could Increase by 50% by the Middle of the Century, 80% of this from Developing Countries.
Total Primary Energy Demand of China – Doubling by 2035 & India by 1.5 Times.
Last 2 Decades – Significant Growth of Global Energy Sector, Higher than anticipated even in High Growth Scenario. More Energy Resources Today than 2 Decades Ago.
Despite CO_2 Emission, Moving Away from Fossil Fuels will take years/decades. 79% of Electricity in China, 60% in India & 40% in US are from Coal.
World is Not Running out of Oil, Crude Oil Reserves 60% more than 2 Decades ago & Production of Oil up by 20%.
Natural Gas will continue to Grow spurred by Falling or Stable Prices – Both in Power & Transport Sector with Contributions from Unconventional – Shale Gas.
Despite Green/Clean, Future of Nuclear (Consequent to Fukushima Daiichi Accident) – Some European Countries withdrawing / some others trying to establish. Depends on Public Acceptance, Costs & Liabilities.
Renewables other than large Hydro – Growth slower than expected 2 decades back. Despite Exponential Growth of Wind / Solar, in % terms Renewable Energy still accounts for a small in TPES in most Countries. **Estimated Global Capacity by 2030 – 10,500 GW from Today's 5500 GW. As per IEA By 2035 Renewable Generation >25%, 1/4th of this from Wind(2nd after Hydro).**

Source: World Energy Resources 2013 – Survey Summary by WEC



Increasing Use of Renewable Energy Sources for Sustainability & Energy Security – Need of the Hour

NTPC's 5 MWp Grid Connected Solar PV Power Plant @ Port Blair, Andaman & Nicobar Islands, India

"It is An Immutable Law in Business That
Words are Words,
Explanations are Explanations,
Promises are Promises,
But ONLY PERFORMANCE IS REALITY"
– Harold S Green

Reducing Carbon Foot Prints & Providing Bountiful Green Energy for A Beautiful Green Island

Bird's Eye View of 5 MWp Solar PV Plant of NTPC @ Port Blair, Andaman & Nicobar Islands India

Green Energy for A Green Island

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REN21 – Renewable Energy Policy Network of 21st Century – A Renowned Global Renewable Policy Multi Stake Holder Network Emerged from the World's First Government Hosted International Conference on Renewable Energy In 2004 @ Bonn / Germany where Delegates from 154 Countries Participated

WEC – Mission Promotion of Sustainable Energy, Established in 1923. Global Energy Organization Represented in 93 Countries.

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